

IN-37

EE23BTECH11063 - Vemula Siddhartha

Question:

The signal flow graph of a system is shown. The expression for $\frac{Y(s)}{X(s)}$ is

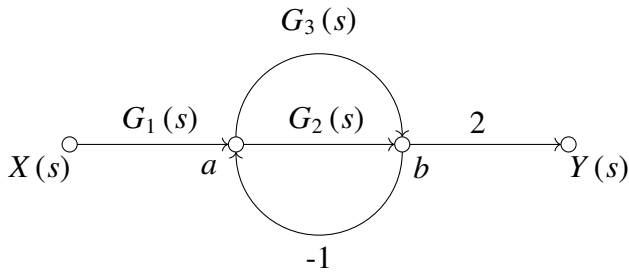


Fig. 0. Signal Flow Graph of the System

- (a) $\frac{2G_1(s)G_2(s) + 2G_1(s)G_3(s)}{1 + G_2(s) + G_3(s)}$
 (b) $2 + G_1(s) + G_3(s) + \frac{G_2(s)}{1 + G_2(s)}$
 (c) $G_1(s) + G_3(s) - \frac{2 + G_2(s)}{2 + G_2(s)}$
 (d) $\frac{2G_1(s)G_2(s) + 2G_1(s)G_3(s) - G_1(s)}{1 + G_2(s) + G_3(s)}$

(GATE 2022 IN Question 37)

Solution:

Parameter	Description	Value
$Y(s)$	Output node variable	
$X(s)$	Input node variable	
$\frac{Y(s)}{X(s)}$	Transfer function	?
P_1	Forward Path Gain a-b through $G_2(s)$	$2G_1(s)G_2(s)$
P_2	Forward Path Gain a-b through $G_3(s)$	$2G_1(s)G_3(s)$
Δ_1	Determinant of Forward Path a-b through $G_2(s)$	1
Δ_2	Determinant of Forward Path a-b through $G_3(s)$	1
L_1	Gain of Loop a-b through $G_2(s)$ and back	$-G_2(s)$
L_2	Gain of Loop a-b through $G_3(s)$ and back	$-G_3(s)$
Δ	Determinant of System	$1 + G_2(s) + G_3(s)$
n	Number of forward paths	2

TABLE 4
VARIABLES USED

$$P_1 = (G_1(s))(G_2(s))(2) = 2G_1(s)G_2(s) \quad (1)$$

$$P_2 = (G_1(s))(G_3(s))(2) = 2G_1(s)G_3(s) \quad (2)$$

$$\Delta_1 = 1 - (0) = 1 \quad (3)$$

$$\Delta_2 = 1 - (0) = 1 \quad (4)$$

$$L_1 = -G_2(s) \quad (5)$$

$$L_2 = -G_3(s) \quad (6)$$

$$\Delta = 1 - (L_1 + L_2) = 1 + G_2(s) + G_3(s) \quad (7)$$

From 0, Using Mason's Gain Formula,

$$\frac{Y(s)}{X(s)} = \frac{\sum_{i=1}^n P_i \Delta_i}{\Delta} \quad (8)$$

$$= \frac{P_1 \Delta_1 + P_2 \Delta_2}{\Delta} \quad (9)$$

$$= \frac{2G_1(s)G_2(s)(1) + 2G_1(s)G_3(s)(1)}{1 + G_2(s) + G_3(s)} \quad (10)$$

$$\Rightarrow \frac{Y(s)}{X(s)} = \frac{2G_1(s)G_2(s) + 2G_1(s)G_3(s)}{1 + G_2(s) + G_3(s)} \quad (11)$$